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ABSTRACT

Most popular strategies, including illustrations, for improving prose processing consist of procedures that force attention either to the text's macrostructure or to the organization and interconnections of its propositions. These strategies are assumed to enhance students' comprehension of the text as encoded, as well as to afford students an efficient storage and retrieval scheme for long-term recall of text information. However, with expository or instructional texts containing factual information that is unfamiliar, complex, abstract, or simply difficult to remember, comprehension strategies of the kind just described may not be suitable for enhancing long-term recall. Rather, mnemonic strategies that are designed expressly for storage and retrieval of difficult-to-remember information would seem to be preferable. This view is supported by several recent experiments showing that prose-learning strategies combining the critical components of comprehension-directed techniques with those of memory-directed techniques will ultimately prove to be the most successful. (FL)

Theoretical Paper No. 93

PICTURES AS PROSE-LEARNING DEVICES

by

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Report from the Program on
Student Diversity and Classroom Processes: Skill Development

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ABSTRACT

Popular strategies for improving prose processing consist of procedures that force attention either to the text's macrostructure or to the organization and interconnections of the text's propositions. These strategies are assumed to enhance students' comprehension of the text as encoded, as well as to afford students with an efficient storage and retrieval scheme for long-term recall of text information. However, with expository or instructional texts containing factual information that is unfamiliar, complex, abstract, or--for whatever reason--simply difficult to remember, comprehension strategies of the kind just described may not be optimally suited for enhancing long-term recall. Rather, mnemonic strategies that are designed expressly for storage and retrieval of difficult-to-remember information would seem to be preferable. Several recent experiments are reported, to provide preliminary support for this view. It is proposed that prose-learning strategies that combine the critical components of comprehension-directed techniques with those of memory-directed techniques will ultimately prove to be the most successful.

The focus of this paper is on pictures as devices for making prose content more memorable. The term "device" was selected to emphasize the bridges that can be built from the basic learning-and-memory literature to the prose-learning domain. I refer, in particular, to mnemonic devices, which have been scrutinized heartily in the context of unconnected word lists, yet hardly in the context of connected discourse (see, Bellezza, 1981; Bower, 1970; Higbee, 1979; and Levin, 1981a). The argument advanced here is that the same kind of mnemonic devices that have brought about dramatic recall increases in simple list-learning experiments can be adapted to yield comparable benefits with respect to information contained in more complex prose passages.

The argument depends critically on the acceptance of certain definitions of and premises about prose-learning strategies, where the term "strategy" refers to any auxiliary materials or learner activities designed to enhance processing of a text. In the first section of the paper, I distinguish between two general classes of prose-learning strategy: (a) strategies directed primarily at the main ideas of a passage; and (b) strategies directed primarily at a passage's factual details. Given these two kinds of general strategy, a further distinction is made between strategies whose primary job is to enhance students' understanding of text information and strategies whose primary job is to enhance a text's memorability. In the next two sections of the paper, pictures are introduced into the prose-learning scenario, along with their presumed functions and consequences. Included here are several recent investigations in which pictorial mnemonic devices have played a central role. Although to date, prose-learning applications of mnemonic devices have been confined mainly to the processing of factual details, the potential of mnemonics for main idea processing is explored in the paper's final section. Of special

significance is the question of the comparative effectiveness of compound mnemonic strategies, alternative nonmnemonic strategies, and mnemonic/nonmnemonic strategy combinations for enhancing students' comprehension and recall of both passage main ideas and details.[1]

Prose-Learning Strategies: Definitions and Premises

Macrostructure Versus Microstructure Strategies

As was just indicated, in this paper a variety of prose-learning strategies are conceptualized in terms of the type of text information for which they appear to be intended. By type of text information, I mean the general level of information within a text hierarchy (i.e., higher-level main ideas on the one hand versus lower-level factual details on the other). In recognition of Kintsch's (e.g., Kintsch & van Dijk, 1978) pioneering work in the area of text analysis, I will refer to those prose-learning strategies that seem to be well suited to the processing of main ideas as macrostructure strategies. As will become apparent, macrostructure strategies are those that are directed toward identifying, analyzing, or integrating information within the text's macrostructure. Of course, the complementary strategies--those that seemingly are intended for the processing of details--will be termed microstructure strategies. This is the general framework that will be adopted throughout the paper, as well as in our discussion of Figure 1, which follows.

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[1] Although the term "mnemonic" can by applied to anything that enhances one's memory, in this paper the term will be used exclusively as an abbreviation for "mnemonic devices" (i.e., systematic techniques that physically transform the to-be-processed stimuli into more memorable representations). For additional discussion of the characteristics of mnemonic devices, see Bellezza (1981) and Levin (Note 1).

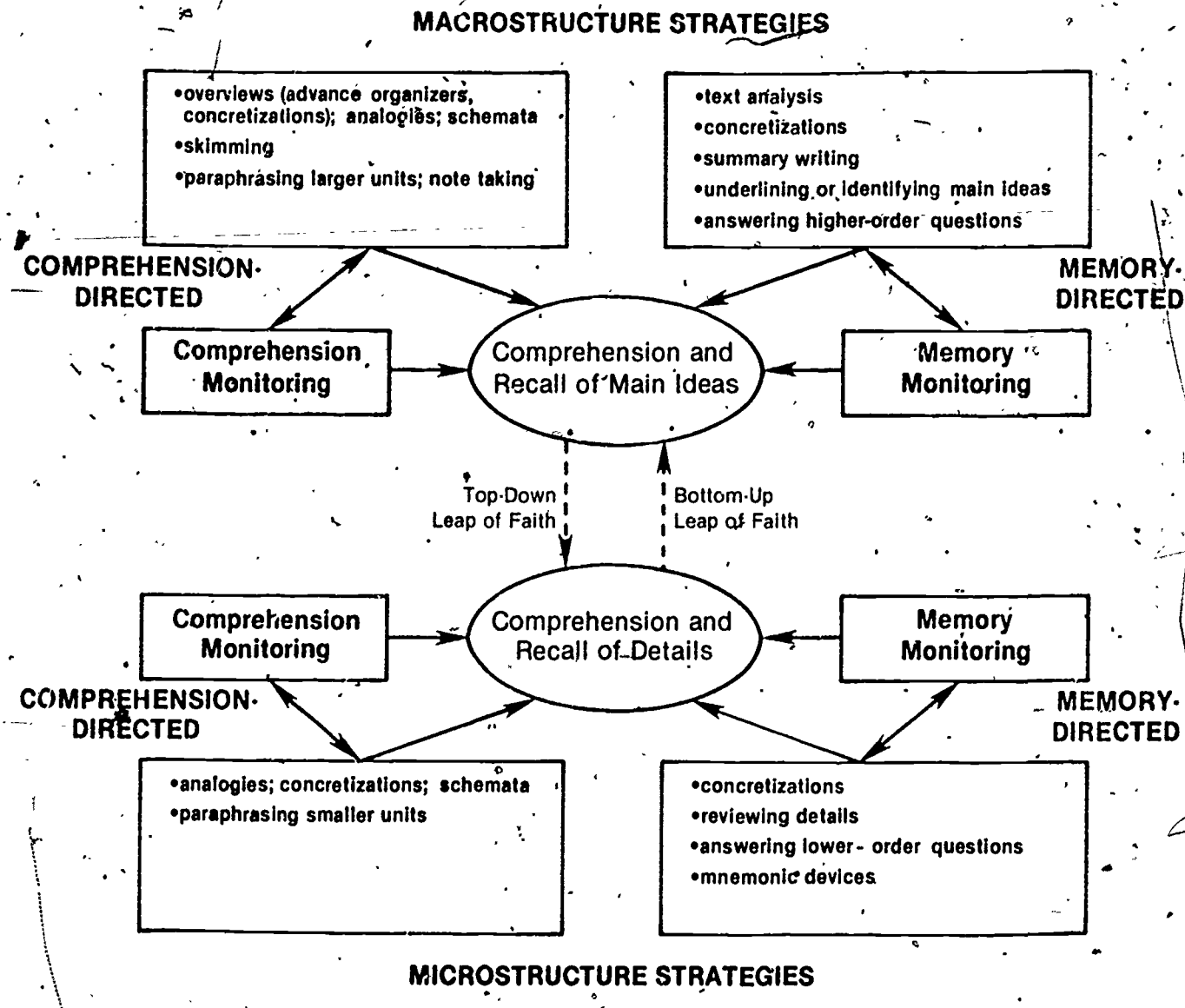

Figure 1. Prose-learning strategies classified according to level of text information and primary cognitive function served.

Comprehension-Directed Versus Memory-Directed Strategies[2]

As may be seen from Figure 1, within the two general classes of strategy just discussed (macro- and microstructure strategies), a distinction can be made with respect to the primary cognitive function presumably served by that strategy. That is, is the strategy one that is intended primarily to enhance the student's comprehension of text that is being, or that is about to be, processed? Or is the strategy one that is intended primarily to improve the student's memory for text that is being, or that has just been, processed? Levin and Pressley's (1981) recent discussion of stage-setting strategies (where the emphasis is on comprehension) and storage/retrieval strategies (where the emphasis is on retention) captures some of the flavor of the present distinction.

At the same time--and as was noted by Levin and Pressley--comprehension- and memory-directed activities are certainly not mutually exclusive. For instance, it is well known that the meaningfulness and comprehensibility of information processed are directly related to the amount of that information later remembered. Yet, even though it may be assumed that enhanced comprehension leads to enhanced memory, the present comprehension/memory distinction appears to be worth making when classifying existing prose-learning strategies. Thus, for example, the strategy of rendering unfamiliar prose concepts more familiar through the use of analogy is viewed primarily as a comprehension-directed strategy, whereas the strategy of rereading (as a form of repetition)

[2]Baker and Brown (in press) have recently distinguished between comprehension and memory purposes for reading, which differs from the strategy function issue discussed here.

is viewed primarily as a memory-directed strategy. In short, comprehension-directed strategies are those designed to enhance a student's conceptual understanding of a text's propositions and the relationship among those propositions; memory-directed strategies are those designed to facilitate a student's later retrieval of text information, assuming that it has initially been adequately understood.

A few additional comments bearing on the comprehension/memory distinction are in order. First, and related to the "nonmutual exclusivity" point mentioned above, sorting popular prose-learning strategies into either comprehension-directed or memory-directed categories is not a straightforward process. As a result, the subjective criteria adopted by the present author can certainly be expected to yield both inter- and intrajudge placements that are less than perfectly reliable. Second, it is readily acknowledged that strategy distinctions along other lines are possible. For example, one could [illegible] prose-learning strategy as directed primarily at processing individual propositions (as in paraphrasing sentences or answering separate and unrelated questions), in contrast to a strategy that is directed primarily at structuring or interrelating those propositions (as in text analysis or in summary writing). Such an alternative formulation may prove similarly useful with respect to the issues raised in this paper.

Specific Strategies Included in Figure 1

Each of the four main corner boxes of Figure 1 includes exemplars of the kind of strategy represented by combining categories of the just-discussed text information (macro- versus microstructure) and cognitive function (comprehension- versus memory-directed) factors. Brief mention will now be made of the specific strategies included in the figure.

Comprehension-directed macrostructure strategies. In the upper left box of Figure 1 are strategies that ostensibly impact directly on one's understanding of a passage's theme, main ideas, major conceptual structures, or interrelationships among the main ideas. Selected from Levin and Pressley's (1981) stage-setting strategies are overviews such as advance organizers (to provide a more general framework for the upcoming passage information) and pictorial concretizations (to provide a more concrete framework). In this box are also included analogies (to render unfamiliar or difficult-to-comprehend conceptual structures more familiar), and schemata (where one's prior knowledge is activated with respect to unfamiliar major concepts within the passage). Whereas the overview strategies are, by definition, exploited prior to passage presentation, capitalization on analogies and schemata can occur during passage presentation as well.

Skimming for upcoming main ideas and concepts is another macrostructure strategy that has been proposed for improving text comprehension. The same can be said for paraphrasing larger units of text (i.e., paragraphs and major sections), as well as its sister strategy, note taking. Placing these latter two strategies on the "comprehension-directed" side of Figure 1 implies that the primary purpose of saying things in one's own words is to force understanding. The rationale for this placement is further bolstered if the paraphrasing/note-taking activity takes place during processing with the text in full view--in contrast to, say, concocting summaries, which typically is attempted following processing, in the text's absence. As such, I regard summary writing as a storage/retrieval (memory-directed) strategy (see the upper right box of Figure 1). I wouldn't think of quibbling with one who argued otherwise, however.

Memory-directed macrostructure strategies. In the upper right box of Figure 1 are strategies that are directed at coding the text's macropropositions for efficient retrieval. Text analysis, for example, is based on the assumption that constructing a hierarchical structure for the text will furnish the constructor with a systematic retrieval plan. That is, the text is coded in terms of a series of higher-to-lower-level nodes, and the most important text information is prominently displayed at the top of the hierarchy. Assuming that the information associated with these nodes is familiar enough (through either prior knowledge or sufficient text processing), then the constructed retrieval hierarchy should indeed be helpful. Yet, even though this may be true for the higher-level propositions in the text, whether or not command of higher-level propositions invariably leads to recall of the lower-level propositions is one of the major issues confronted in this paper.

Concretizations here include pictorial representations of the macrostructure to make it more memorable. The use of maps, graphs, flowcharts and other visual depictions of the superordinate concepts in the text--or the relationships among these concepts--would certainly fill a concretization-of-macrostructure-bill. Reliance on the initially encoded concretizations for furnishing information-retrieval cues would, in addition, qualify such entries as memory-directed.

The technique of summary writing was discussed previously, along with my rationale for viewing it primarily as a memory-directed strategy. By placing it in the "macrostructure" category, I am assuming that a good summary results in a considerable reduction of the original text content, and that the reduction contains the most important passage information (see

Brown, Campione, & Day, 1981). Underlining or identifying main ideas is basically a form of rereading rehearsal, in which important concepts are stored for future use. A similar type of memory-storage strategy consists of answering higher-order questions (i.e., questions directed at main ideas or those requiring inferences involving main ideas).

Comprehension-directed microstructure strategies. In this category (lower left box of Figure 1) are included techniques that serve to elucidate factual information within a passage. As was stated in regard to macropropositions, providing analogies (or alternatively mobilizing a learner's schemata) can serve this function well. Concretizations typically involve pictorial representations of abstract or otherwise difficult-to-comprehend factual information. Political cartoonists make habitual use of such comprehension-enhancing tactics. Whereas analogies are regarded as translations involving a vehicle that is removed from the actual text content, other concretizations of the comprehension-directed microstructure kind rely heavily on the use of conventional symbols and other pictorial auto-translations of the information being conveyed. For example, in one study to be reported later, we translated a high level of literacy into a picture of numerous books, advances in technology into a picture of a computer terminal, abundant natural resources into a picture of an oil well, etc.

Paraphrasing smaller units of text (i.e., individual details and sentences) is regarded as another technique for enhancing one's comprehension of a passage's micropropositions. As was mentioned previously, the case for calling paraphrasing a "comprehension-directed" strategy would appear

to be strengthened if the activity takes place during processing, with the text in view.

Memory-directed microstructure strategies. The final set of strategies appears in the lower right box of Figure 1. Concretizations here include direct pictorial representations of the text's factual details. Most experimental investigations of the efficacy of visual illustrations and visual imagery have employed this kind of strategy (see Levin, 1981b; and Levin & Lesgold, 1978).

Reviewing details, as a rereading activity, is a form of rehearsal in the service of memory, and answering lower-order questions (i.e., questions directed at factual details) is regarded as another form of information storage/retrieval activity. As will be argued here, however, the most effective techniques for remembering a passage's factual information are those based on the application of mnemonic devices. Whether or not such devices can be applied with similar success to a text's macrostructure is an issue that will be examined as we progress.

Strategy Monitoring

An additional component of Figure 1 consists of students' metacognitions about how successfully they are processing a text, reflected by students' monitoring of their comprehension of and memory for what they are studying. "Do I or don't I understand this information?" and "Will I be able to remember it?" are the relevant questions here (see, for example, Baker & Brown, in press; and Flavell, 1978).

Strategy monitoring is viewed as a cybernetic process, with effective monitoring providing information concerning the effectiveness of strategy implementation. That is, the degree of strategic processing of text

segments is regulated by one's own monitoring behavior. This regulatory activity is reflected by the solid bidirectional arrow between each strategy box and its respective monitoring box. Note also that the degree of effective monitoring is assumed to have a direct effect on the amount of text information comprehended and remembered.

Relationship Between Strategy Implementation and Text Information Processed

In Figure 1, the solid unidirectional arrows between the strategy boxes and the performance ovals indicate the direct effect that the degree of effective strategy implementation is assumed to have on one's level of comprehension and recall of text information at the same level of structure. This last qualifier is extremely important, and central to the arguments advanced in this paper. Thus, prose-learning strategies that focus on a text's macrostructure can reasonably be assumed to have a direct facilitative effect on students' comprehension and recall of text macrostructure information (i.e., a passage's higher-level propositions). A similar statement can be made for microstructure strategies and microstructure information (i.e., a passage's lower-level propositions). But surely it is a considerable leap of faith to assume that a strategy suited for one type of information processing (either "macro" or "micro") will have a direct facilitative effect on the opposite type of information. This skepticism is reflected in both the extant empirical data that adequately address the issue and the dashed arrows of Figure 1. Expecting that the implementation of macrostructure strategies will directly facilitate students' storage and retrieval of microstructure information

is viewed here as a top-down leap of faith, whereas the reverse strategy/performance expectation is viewed as a bottom-up leap of faith. Of course, indirect facilitative effects might be posited in each case, but the associated cognitive processes and mechanisms responsible for such facilitation are far from obvious, as is discussed in more detail later in the paper. For now, suffice it to say that there is no compelling reason to expect that increased comprehension of a text's macrostructure (say, through the provision of a coherently and transparently structured text, or by casting the appropriate anchors to a student's schemata) will facilitate one's subsequent recall of specific micropropositions within the text. Yet, such facilitation has indeed been implied (e.g., Pearson & Spiro, 1980), if not regarded as fact.

Pictorial Prose-Learning Strategies

Having considered all the various ingredients of Figure 1, I will now attempt to mix in a dash of picture theorizing. In particular, I will try to fit some recently posited "functions" of prose-learning pictures (Levin, 1981b) into the conceptual framework just developed. Throughout the discussion, pictorial strategies will include both text-embedded visual illustrations (on the page) and student-generated visual imagery (in the head).

Summary of Pictures' Major Functions

Levin (1981b) ascribed eight different functions of prose-learning pictures, four of which were deemed interesting from a cognitive-psychological perspective. These "interesting" functions will be briefly reviewed.

Representation function. It is often the case that a verbal text can be equivalently expressed as a sequence of pictures. Consider, for example,

a concrete narrative passage, where it is possible to construct parallel verbal and pictorial forms (e.g., Baggett, 1979). When the pictures accompanying a prose passage are virtually redundant (i.e., overlapping) with the verbal information contained in that passage (Levin & Lesgold, 1978), then pictures are serving a representation function. Verbal information represented via pictures is assumed to be more concrete, and more concrete representations are known to be more memorable (Paivio, 1971).

Organization function. With certain types of passages, pictures are called on to do more than simply represent the text information as given. Rather, restructuring or reorganizing that information may be accomplished through a map or graph. Similarly, a single integrated illustration can conveniently expose a text's interpropositional relationships. Integrating propositions is critical for establishing efficient retrieval structures, and all too often such integration is either lacking in, or only implicitly provided by, the text itself (see Gagné & Bell, 1981). Moreover, even when propositional connections are adequately signaled in a text, pictures may facilitate the perception of those connections by individuals who lack the comprehension skills necessary to benefit from the provided passage structure (see, for example, Levin, 1973). Pictures that enhance the relatedness of the textual elements are said to be serving an organization function.

Interpretation function. Text information that is abstractly or complexly presented can clearly profit from the provision of pictures. Picture yourself, for example, in an experiment where the following excerpt is presented:

> The presence of a foreign particle or impurity in the chemical composition of the metal also reduces the efficiency of heat transfer in the medium. This is because the particle produces a distortion in the structural symmetry of the crystalline lattices. The result is that some of the molecules in the medium will be moved into oblique positions, with a resultant loss of thermal agitation transfer. The impurity produces this loss of efficiency in two ways. It absorbs some of the energy instead of passing it on, and because of the fact that the impurity is not as structurally bonded as the crystal lattices, it moves erratically, thereby disturbing the normal transfer of energy (Royer & Cable, 1976, p. 207).

This is not one of John Bransford's passages that is written expressly to be ambiguous and uninterpretable. The meaning is in the message as presented. All one needs is an electrochemistry major to crack the code! Or, as Royer and Cable (1976) found, providing students with either concrete analogies or pictorial translations also serves to enhance comprehension. For the above passage, the analogy of inserting a cigarette package into a sequence of toppling dominos was used as a comprehension-enhancing vehicle; as were conventional illustrations of the concepts described (e.g., the internal structure of metals and nonmetals, heat transmission, and disruption due to pressure and impurity). When pictures are used to increase the meaningfulness of the information that is being processed, the interpretation function of pictures is being served.

Transformation function. Finally, and as represented by the title of this paper, pictorial mnemonic devices can also be summoned up to operate on a text. The chief application of such devices to date has been with comprehensible texts containing unfamiliar terminology (e.g., various

technical passages) or with texts containing a good deal of factual information, as in the following social studies passage:

> The southern area of Mala can best be described as a desert. Rainfall is less than 2 inches per year in southern Mala. The soils in the southern area of Mala are either rocky or sandy. In the summertime temperatures have been recorded as high as 135 degrees in southern Mala.
>
> The history of Mala has been marked by exploitation. The first slaves were forcefully taken from Mala to Europe in 1610. When Europeans came over to Mala to settle there, they never paid the Malans for the land they occupied. Prior to the coming of the Europeans, Arab nomads frequently plundered villages in Mala (Rickards & DiVesta, 1974, p. 355; adapted from Bruning, 1970).

Unlike the Royer and Cable (1976) excerpt presented to illustrate relative uninterpretability, in the passages referred to here interpretability is not the problem. New terms are adequately defined or exemplified, and the factual information presented in the form of names, dates, events, event sequences, etc., is straightforward enough. The problem with such passages, however, is one of how to store that information in the most efficient manner for later retrieval. In a text loaded with definitions and facts, this information-storage/retrieval problem is certainly not a trivial one. By taking the text as presented and mnemonically operating on it to produce a physically different text as encoded, one can exploit the transformation function of pictures. Such pictorial transformations are assumed to enhance directly the memorability of the text content.

Relationship of Picture Functions To Strategy Classifications

We will now examine the four picture functions just discussed, in relation to the four main strategy boxes of Figure 1. A distilled version

of Figure 1 is presented as Table 1. As was indicated in our earlier discussion of Figure 1, it must be pointed out that: (a) the distinctions made here should be regarded more as predominant than as exclusive labels; and (b) the particular boxes to which the picture functions have been assigned could be contested. With these caveats in mind, let us proceed.

On the comprehension-directed side of Table 1 are located pictures that satisfy the interpretation function. Note that such pictures can be devised to clarify aspects of a text's macrostructure (e.g., pictorial overviews and pictorial analogies), as well as to clarify the micropropositions themselves (e.g., pictorial interpretations of abstract concepts and details, as in the previously presented Royer & Cable, 1976, excerpt).

In contrast, the three picture functions located on the right side of Table 1 are seen as memory-directed. As mentioned at the outset, however, the distinction is certainly not cut-and-dried. For example, it has been shown that enhanced concreteness (à la the representation function) results in enhanced comprehension per se (e.g., Johnson, Bransford, Nyberg, & Cleary, 1972). Yet, in Table 1 the primary beneficiary of pictorial representations is assumed to be memory. The case for such a placement is strengthened by the numerous studies in which it has been found that even easily comprehended text is more memorable in the company of pictures (see Levin, 1981b; and Levin & Lesgold, 1978). On the other hand, arguing for memory over comprehension is less persuasive with respect to, say, complex procedural ("How To...") texts, where pictorial representations undoubtedly serve to enhance one's initial understanding of the component operations (e.g., Stone & Glock, 1981).

Table 1

Picture Functions Classified According to Level of Text Information and Primary Cognitive Function Served

Level of Text Information	Primary Cognitive Function: Comprehension-Directed	Primary Cognitive Function: Memory-Directed
Macrostructure	Interpretation[a]	Organization[b]
Microstructure	Interpretation[a]	Representation[c] Transformation[d]

[a] Enhanced meaningfulness

[b] Enhanced relatedness

[c] Enhanced concreteness

[d] Enhanced memorableness

Satisfying the representation function are pictures that overlap with a text's micropropositions (e.g., illustrated factual details); satisfying the organization function are pictures that operate on the text's macrostructure (e.g., maps, flowcharts, graphs), as well as those that provide explicit interproposition integrations where these are lacking. Finally, pictures that permit efficient mnemonic codings of a text's factual information satisfy the transformation function. Rather than simply to list examples of the uses to which transformational prose-learning pictures have been put, I will consider these in detail in the remainder of the paper. Consideration will also be given to the possibility of elevating the transformation function to the "level" of various macrostructure strategies--either through its own efforts or on the coattails of currently existing macrostructure strategies.

Pictorial Prose-Learning Mnemonic Strategies

Mnemonic Versus Nonmnemonic Strategies

Numerous prose-learning studies have been conducted in which the effects of "mnemonic" pictorial materials and strategies have been scrutinized. When the studies themselves are scrutinized, however, it becomes clear that the materials and strategies employed are not "mnemonic" at all, in the sense intended in this paper. Thus, researchers who have either provided text-related illustrations or instructed students to generate visual images of a passage's content are not exploring the "mnemonic" domain. Constructing pictures of the text as presented--either through illustrations or imagery--is exploiting the representation function of pictures. The construction of additional pictorial elaborations and connections brings the organization function into play. Finally, the anchoring of

such pictures onto familiar schemata, analogies, or symbols is to involve the interpretation function.

In contrast, being "mnemonic" implies a physical recoding of the text as presented--not just displaying, extending, or "hypostatizing" (Davidson, 1976) it in picture form. Simply stated, mnemonic pictures implicate the transformation function. A characteristic of mnemonic pictures is that they prominently display objects or events that are not even mentioned in the text--and that may, indeed, be semantically unrelated to the prose content. These prominently displayed objects or events are representations of the recoded or transformed text, which provide efficient retrieval paths back to the corresponding text content.

To help concretize these notions, let us consider a factual prose passage in which one or more names, terms, labels, etc., is accompanied by one or more attributes, facts, concepts, etc. In this section, we develop some mnemonic picture constructs for simple passages of this type. In the final section of the paper, extensions are made to more complexly structured texts (i.e., multilevel texts with multiply-connected propositions).

Table 2 contains a summary of pictorial strategies that could be applied to simple factual prose passages of two types. Single-name passages are those that define or describe the attributes of only one subject label. An example of this type of passage is the previously presented Rickards and DiVesta (1974) excerpt, where several attributes were to be associated with the name concept, Mala. In that passage, a number of specific attributes are described within each of two general attribute domains (geography/climate and exploitation history). The second type

Table 2

Pictorial Strategies for Factual Prose Passages

A. Single-Name Passages

1. Nonmnemonic pictorial strategies

- separate pictures of attributes (representation function)
- integrated picture of attributes (organization function)
- meaning-enhancing pictures of attributes (interpretation function)

2. Mnemonic pictorial strategies (transformation function)

- ordered mnemonic pictures (loci, pegword, digit/symbol variations)

B. Multiple-Name Passages

1. Nonmnemonic pictorial strategies

- meaning-enhancing pictures of name/attribute associations (interpretation function)

2. Mnemonic pictorial strategies (transformation function)

- unordered mnemonic pictures (keyword variations)

of factual prose passage represented in Table 2 is the multiple-name passage, where two or more different name concepts are each accompanied by a set of attributes. An example of this type of passage will be provided shortly.

Single-Name Factual Passages

Let us begin with single-name passages and, in particular, the first paragraph of the Rickards and DiVesta (1974) excerpt. Essentially we are given four geography/climate attributes to associate with a place by the name of southern Mala:

1. It is a desert.
2. It receives less than two inches of rain per year.
3. Its soil is either rocky or sandy.
4. Its temperature can reach 135° in the summertime.

Suppose that one's goal is to store these four characteristics of southern Mala, so that they can be recalled or recognized at a later time.[3]

Illustrations serving each of the four picture functions could be constructed to capture various aspects of the southern Mala attributes. Representational pictures would, where possible, afford literal depictions of the separate attributes. For example, a desert could be displayed

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[3] To be sure, this particular four-attribute cluster is one that likely could be easily constructed from a general desert schema and in that sense, the particular attributes listed are not "passage dependent" (Tuinman, 1973-74). Yet, even though this excerpt contains a particularly easy-to-recall set of attributes, we continue to use the example to illustrate a variety of pictorial strategies. Note, as well, that the specific numerical values mentioned in the passage (less than 2 inches of rain per year and summer temperatures of up to 135 degrees) could not be produced exclusively from a general desert schema.

(Attribute 1), as could the two soil types (Attribute 3). Attributes 2 and 4 could only be represented in a rough way through, say, arid-looking conditions and the sun shining brightly, respectively. Depicting all four of the above in a single integrated picture would fulfill the organization function. Capitalizing on the interpretation function could take several different forms here. Were the student already familiar with certain aspects of the name concept being discussed (through prior knowledge or instruction), the newly presented attribute information could be pictorially anchored to the old in a variety of ways. In other cases, where the student has no existing schemata for the name concept, one could exploit a student's prior knowledge of the attribute concepts. For example, one could provide illustrations and graphs in which the attributes of southern Mala are juxtaposed with those of some other place(s) with which the student is presumably familiar. One could also use pictorial analogies to provide students with an answer to the question, "How hot is it?" In addition, one-step-removed symbolic representations could show a rain gauge recording less than 2" or precipitation and a thermometer registering at 135°. Finally, it should be mentioned in regard to pictorial interpretations that they can be combined with pictorial organizations to produce memorial benefits likely to be greater than those associated with either separately. More will be said later about such pictorial strategy combinations.

The just-discussed pictorial approaches are, by definition, nonmnemonic inasmuch as they do not involve the transformation function. It will also be argued--as a point for subsequent empirical challenge--that none of these nonmnemonic approaches is as memorially potent as are the true mnemonic approaches to be discussed now. Of course, not all mnemonic techniques

can be expected to be equally effective. And given the large number of candidate techniques available (see Bellezza, 1981), I am forced to be selective here. Thus, excluded from present consideration are the first-letter-mnemonic method and other verbal-based procedures. Also excluded temporarily is the link method, which will surface in a subsequent context. Three mnemonic pictorial strategies will be considered: the method of loci, the pegword method, and the digit/symbol method. Each of these is specialized for storing and retrieving a list of information, as is desired for the southern Mala attributes of present concern. All of the techniques make use of pre-established concrete "codes", "pegs", or "hooks" and, because they all involve variations of the same theme, all three techniques will be described first before adapting them to our southern Mala example.

The method of loci. With this approach, one hooks new information onto an overlearned set of ordered locations (loci). Commonly used loci are rooms in one's house, stores along a neighborhood street, and campus landmarks, as one proceeds along a familiar route from Point A to Point B. As alternative "loci", we have constructed scene settings out of the four seasons, as well as out of the 26 letters of the alphabet (Levin, 1981a). To use the latter system, for example, one simply pictures the first to-be-acquired piece of information in an airplane scene, the second in a bank scene, the third in a circus scene, the fourth in a doctor's office scene, etc.

The pegword method. Here, the pre-established codes are simple picturable words that are rhyming proxies for various numbers. Thus, 1 is a bun,

2 is a shoe, 3 is tea, 4 is war, etc. Each incoming piece of information is pictorially related to a specific numerical peg, and these pegs later serve as information-retrieval cues. A limitation of this method is that convenient rhyming words have been devised for only the first 10 (or, in some systems, for the first 20) integers. A similar limitation is associated with the previously discussed alphabet-scene loci method, where only 26 different scenes can be constructed. Note, however, that these two methods can be combined to yield an efficient retrieval system for up to 260 pieces of information. The first ten pieces of incoming information (1-10) are coded by imagining an airplane scene with one of ten objects in it (1 = bun, 2 = shoe, ... , 10 = hen), the next ten pieces of information (11-20) by imagining a bank scene with one of these same ten objects in it, etc., all the way to the 251st through 260th pieces of information by imagining a zoo scene. A more complex system, whose capability for storing serially presented information is virtually limitless, will now be described.

The digit/symbol method. With this method, the digits 0-9 are each represented by a consonant sound. Specifically, 1 is represented by a t or d sound, 2 by an n sound, 3 by an m sound, 4 by an r sound, 5 by an l sound, 6 by a j, ch, sh, or soft g sound, 7 by a k, hard c, or hard g sound, 8 by an f, v, or ph sound, 9 by a p or b sound, and 0 by an s, z, or soft c sound. Each of these sounds or sound combinations is then coded as a picturable word. Vowels, unvoiced consonants, and the consonants, w h, and y are not associated with any numerical values in the resulting words. In one system, for example (Lorayne & Lucas, 1974), 1 = tie, 2 = Noah, 3 = ma, 4 = rye, 5 = law, ... , 13 = tomb, ... ,

25 = nail, ... , up to 100 = disease. Beyond 100, one can always invent something, such as 135 = tamale, etc., up to a wordsmith's infinity. Each of these number → consonant → word pictures is then associated with the corresponding piece of new information.

Examples of the three mnemonic techniques just described have been constructed for the four geography/climate attributes of the Mala excerpt. These are displayed in Table 3. Note, as well, that there are two obvious attribute distillations in that table: Attribute 2 (less than two inches of annual rainfall) was "gisted" as little rainfall, and Attribute 4 (summer temperatures as high as 135°) was "gisted" as very hot temperatures. Suppose, instead that the student thought it important to remember exactly how much rainfall and how much heat were associated with southern Mala. Using, say, the pegword method to represent the four attributes, one could add specific digit/symbol recodings where appropriate. Thus, to represent "less than two inches of rain", Noah (?) could be wearing the shoe that is collecting rain droplets; and to represent "temperatures as high as 135°", a war among Mexican soldiers (or Mexican waiters) over a prominently displayed tamale (135) would do the job.

Before moving on to the multiple-name factual passages, I would like to make two additional comments about pictorial mnemonic strategies in the present single-name context. First, and as may have been inferred from the examples presented in Table 3, mnemonic pictures clearly make use of all three other picture functions. The airplane landing in the desert combines the pre-established airplane scene with a literal desert representation. All of the mnemonic techniques involve the organization

Table 3

Sample Mnemonic Pictures for the Single Name Mala Excerpt

Mnemonic Technique	Pre-established Codes	Distilled Attribute: 1. Desert	2. Little Rainfall	3. Rocky or Sandy Soil	4. Very Hot Temperatures
Method of Loci	1 = a = airplane 2 = b = bank 3 = c = circus 4 = d = doctor's office	An airplane landing in the desert	A tiny puddle of rain droplets forming inside a bank vault	Two circus elephants, one atop a big rock pile and the other atop a big sand pile	A doctor taking a patient's temperature that is at the high end of the thermometer
Pegword Method	1 = bun 2 = shoe 3 = tea 4 = war	Lawrence of Arabia eating a hamburger bun in the desert	A shoe filling with tiny droplets of rain	A tea party, where one group of people is sitting on a rock pile and another group is sitting in a sand box	A war in which soldiers are wiping their brows as a result of the hot sun beating down on them
Digit/ Symbol Method	1 = t or d = tie 2 = n = Noah 3 = m = ma 4 = r = rye	Lawrence of Arabia putting on a flashy tie in the desert	A very confused Noah looking up to see only a few droplets of rain!	One's mother stacking a load of rocks around a sand pile	A delicatessen, where customers in a line to purchase rye bread are wiping their brows because of the heat

function to some degree, inasmuch as the various picture components that are produced (from either external- or internal-to-text sources) must be integrated in some meaningful fashion. Finally pictorial interpretations based on schemata (e.g., Noah's flood) and once-removed-from-text symbolic representations (e.g., a doctor's thermometer) are often included in one's mnemonic transformations.

A second point of interest is that any of the three mnemonic methods represented in Table 3 could very easily be extended to encompass the additional information in the second paragraph of the Rickards and DiVesta (1974) excerpt, namely information documenting Mala's history of exploitation. Another four attributes, distilled from that paragraph, can be extracted and added to the four of the initial paragraph. A simple way to do this would be just to label them Attributes 5-8 and continue using any of the three counting systems described. Or, if one preferred, these could be regarded as Attributes 1-4 of a new attribute category, and then the same loci, pegwords, or digit/symbols that were applied in the first paragraph could be reused in the second. That multiple applications of the same mnemonic codes is an easily managed, noninterfering process has been well-documented in the literature (see for example, Bellezza, in press). Of course, it might be desirable to tag the two superordinate attribute categories (geography/climate and exploitation history) in some distinctive fashion. Such tagging could be considered from either a mnemonic or nonmnemonic perspective--the subject of this paper's final section.[4]

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[4]For those few who may care: Using the digit/symbol method, one would recode the critical year of 1610 as "two jets", "two sheets", "tee shots", "digits" (among others), and then incorporate the corresponding literal or figurative representation into one's picture.

Multiple-Name Factual Passages

The strategies for enhancing students' recall of information in single-name, multiple-attribute passages are general strategies for enhancing free or serial recall. These include semantic categorization, organization, and association strategies; that is, strategies designed to increase the integration or connectedness of the attributes presented. An important characteristic of such strategies is that they are directed exclusively toward the attributes themselves.

In contrast, with multiple-name passages one cannot ignore which names go with which attributes. Thus, for example, even though one may remember perfectly the set of attributes for southern Mala, it does no good if one believes that these attributes are associated with the arctic community of northern Pola (see also Bower, 1973, p. 70). Appropriate connections between specific names and specific attributes (or attribute clusters) are essential for multiple-name passages and, consequently, facilitative strategies are those that strengthen not just the inter-attribute links but especially the name/attribute links.

As may be seen in Table 2, nonmnemonic pictorial strategies for achieving name/attribute integrations depend on the interpretation function. And, as was mentioned in the case of single-name passages, the activation of a student's relevant schemata would be a primary ingredient. Note, however--and this is critically important--that such pictorial interpretations will be helpful only to the extent that the student has some prior knowledge about the particular name concept being considered. Consider, for example, the difference between acquiring new information for somewhat familiar

places [i.e., places whose names are already stably encoded in memory, along with schema rubrics (e.g., Transylvania, Oz, or Camelot)], as opposed to completely novel ones (e.g., Tergomania, Od, or Cumuland). With the former familiar places, there are anchors there to which new information can be attached; with each of the latter unfamiliar places, however--and as Gertrude Stein would have said--there is no there there. In contrast, it will now be shown that mnemonic pictorial strategies can be effectively applied even to name concepts that are lacking a "there."

The keyword method. Based on the age-old mnemonic notion of recoding unfamiliar terms into familiar picturable ones, the keyword method (Atkinson, 1975) has been successfully applied to a variety of educationally relevant tasks containing an associative element (see Levin, 1981a; and Pressley, Levin, & Delaney, Note 2). The keyword method includes the two basic components of associative mnemonic devices, phonetic recoding and semantic relating (Levin, Note 1). Thus, for example, to remember that a woman named McKune was famous for owning a cat that could count: (1) In the phonetic recoding stage, one would recode the unfamiliar name McKune into an acoustically similar, more concrete representation, such as raccoon. (2) Then, in the semantic relating stage, one would integrate the recoded name with either a literal or figurative representation of the attribute associated with that name (in this case, what the person was famous for). Thus, to link raccoon with counting cat, one could picture, say, a cat standing beside a tally board, counting raccoons as they jump over a fence. Each other unfamiliar name would be recoded and related in similar fashion.

Multiple-Name Applications Based on the Keyword Method

We have conducted just such a names-and-accomplishments adaptation of the keyword method, embedding it in a prose-learning context. I will only briefly discuss the results of that particular effort here, however, in that more detailed information about it has been recently provided (Levin, 1981b; Shriberg, Levin, McCormick, & Pressley, in press). The names-and-accomplishments study will illustrate application of the keyword method to multiple-name factual passages containing only one attribute per name. Two other very recent investigations out of our laboratory will then be detailed to illustrate application of the keyword method to multiple-name factual passages containing multiple attributes per name. As will be seen shortly, the collective results of the three studies provide us with interesting information concerning the benefits to be expected from various pictorial strategies accompanying factual prose passages. In all of the studies to be discussed, the subjects were junior high school students. Each of these studies will be organized around the major question it was designed to address.

Can the keyword method be successfully applied to factual prose passages? In the Shriberg et al. (in press) study, 12 short paragraphs were written to describe the accomplishments of "famous" people (actually fictitious accomplishments paired with names randomly drawn from the phone book). Thus, one paragraph described Charlene McKune and her counting cat; another described Douglas Rice, the inventor of a disappearing potion; a third described Vicki Poulos, who achieved fame by floating across the Atlantic on her back; etc. Keyword subjects were provided with a keyword for each surname (e.g., McKune = raccoon; Rice = rice; Poulos = pole) and either actual illustrations that related the keyword to the accomplishment or

instructions to create such a relationship via visual imagery. Three experiments were conducted to address different practical and theoretical issues surrounding use of the keyword method in this context, including an empirical assessment of the transformation vs. representation functional distinction that was made earlier in this paper. The major results (based on cued-recall questions) can be summarized as follows:

1. The keyword method (as manifested through pictorial transformations) greatly facilitated students' name/accomplishment recall in all three experiments.

2. This was true whether actual keyword illustrations were provided by the experimenter or whether the students generated their own keyword images. It was found, however, that--at least for students of junior high school age--experimenter-provided illustrations were more effective (over 200% facilitation) than subject-generated images (over 100% facilitation).

3. Incorporating keyword pictures into more detailed (representational) illustrations did not materially diminish the just-noted facilitative effects. At the same time, these representational pictures tended to improve students' memory for the passage details that were pictured.

4. This latter result, along with the finding that pictures that simply represented the literal (untransformed) text information did not facilitate name/accomplishment recall, provided solid evidence for the transformation-representation distinction. In particular, simple pictorial representations might be expected to enhance recall of the information depicted, but pictorial transformations are required to enhance recall of the critical name/accomplishment associations.

Can the keyword method be successfully applied to relatively abstract prose information? We (Shriberg, Levin, & Berry, Note 3) have recently completed four experiments in which students were given prose passages containing the distinguishing attributes of various fictitious communities such as Hammondtown, Pleasantville, Fostoria, etc. Each of the 20 attributes generated was randomly assigned to a particular community. Consider, for example, the following paragraph about Fostoria and its four attributes:

> Fostoria has a lot to offer its people. People have considerable wealth, and everyone lives comfortably. Many of the townsfolk also become quite prosperous because the land has abundant natural resources. In addition, the town is especially well known for its advances in technology, for just about everything is run by computer. This progress has attracted many new residents, and statistics show a growing population.

After studying several such paragraphs, students in two experiments were required to match community names with their attributes (associative recognition), and students in the other two experiments had to list the characteristics for each community name (associative recall). In one of the recognition experiments, there were ten community paragraphs with two attributes per community. In the other recognition experiment and in the recall experiments, there were five community paragraphs with four attributes per community.

Unlike the Shriberg et al. (in press) attributes, most of those mentioned in the present study were considerably less concrete, in the sense of their not being amenable to direct pictorial representation. Contrast, for example, the means of depicting a counting cat or someone floating on one's back in the ocean vs. considerable wealth and abundant natural resources. Clearly, one-step-removed pictorial interpretations are needed in the latter case, in the form of symbolic representations (e.g., a stack of dollar bills for

considerable wealth) and specific concretizations (e.g., an oil well for abundant natural resources). One of the major questions in this series of experiments was, Would the keyword method be adaptable to relatively abstract attributes of this kind?

In these experiments, the comparative effects of pictorial interpretations per se, interpretations plus organizations, and interpretations plus organizations plus transformations, were respectively examined in the following manner: (i) in the Control condition, after studying each paragraph students were presented a page on which the attributes for that paragraph were summarized; (ii) in the Picture condition the summary page following each paragraph contained separate pictorial symbols to represent the attributes (see Figure 2 for the four symbolized Fostoria attributes); (iii) in the Organized Picture condition, the pictorial symbols on the summary page were presented in the context of an integrated illustration, as in Figure 3; and (iv) in the Organized Keyword Picture, a picture of the keyword for the particular community (e.g., Fostoria = frost) was incorporated into the integrated illustration, as in Figure 4.

Whether or not pictorial interpretations per se (Picture condition) would facilitate students' acquisition of community/attribute associations was not known. It was predicted, however, that whereas both picture organization conditions (Organized Picture and Organized Keyword Picture) would be facilitative with respect to associating the appropriate attributes with one another, the Organized Keyword Picture condition would be additionally facilitative with respect to associating the attribute clusters with their appropriate community names. An additional question of interest in the recall experiments was, How well would picture subjects be able to recall verbatim

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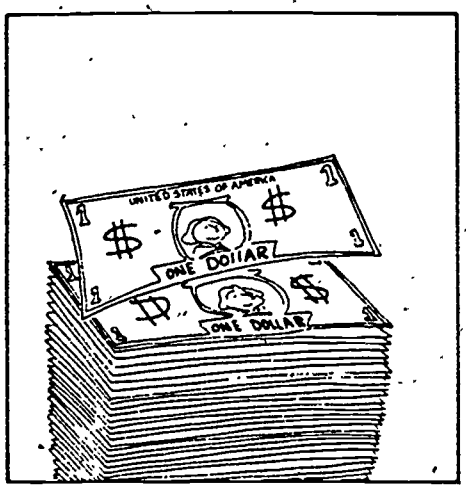

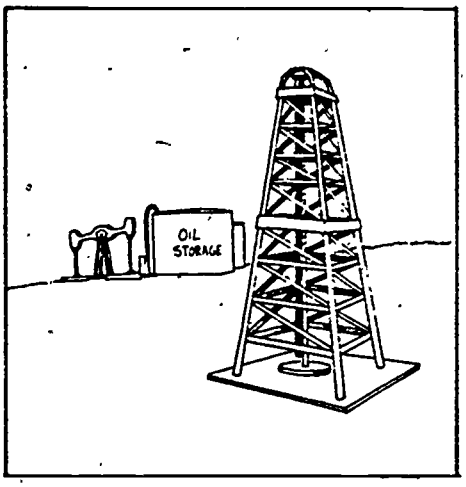

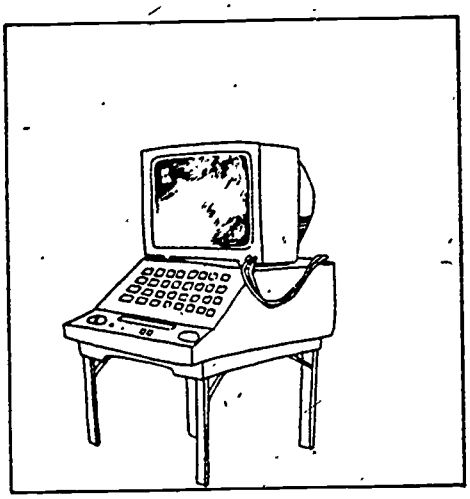

Figure 2. Sample illustration for the Picture condition (From Shriberg et al., Note 3).

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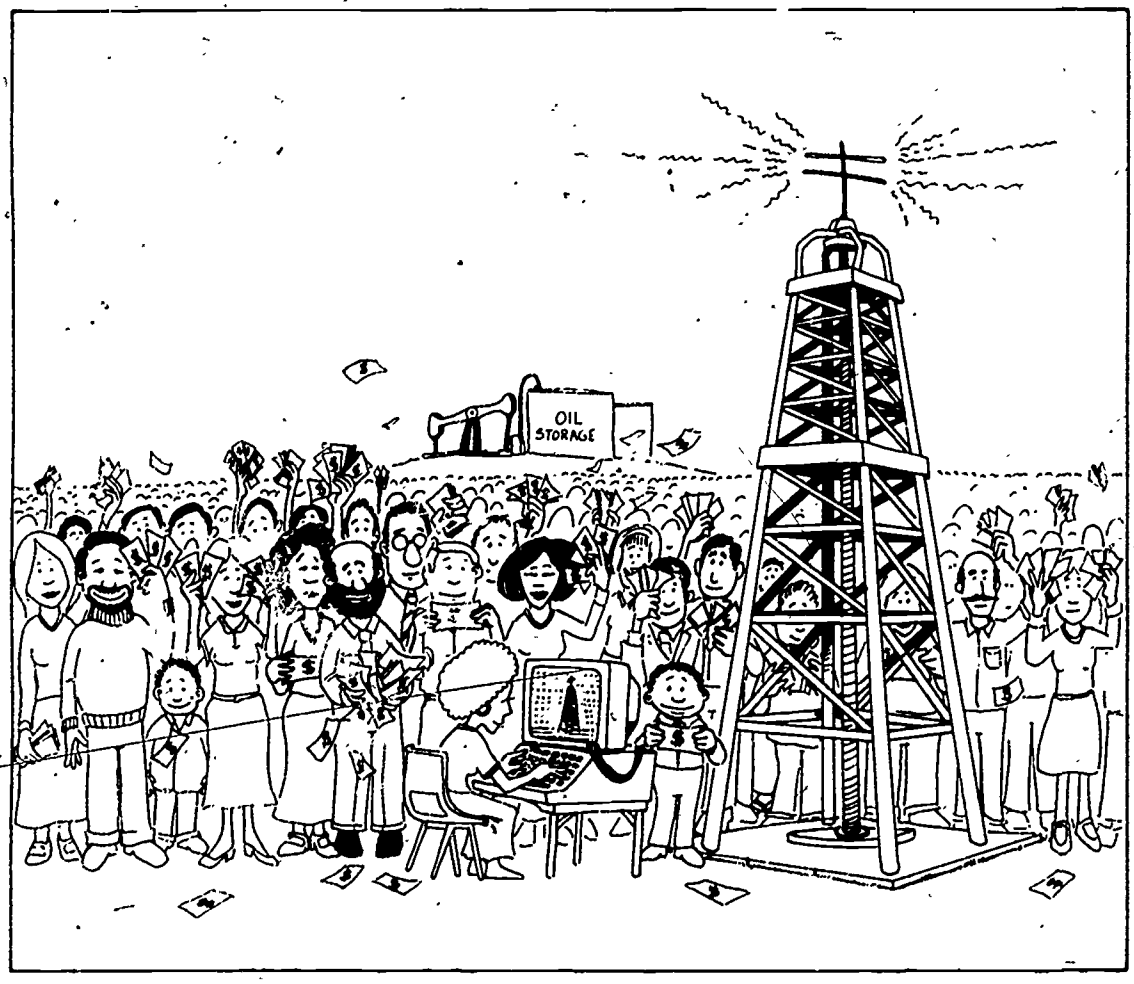

Figure 3. Sample illustration for the Organized Picture condition (From Shriberg et al., Note 3).

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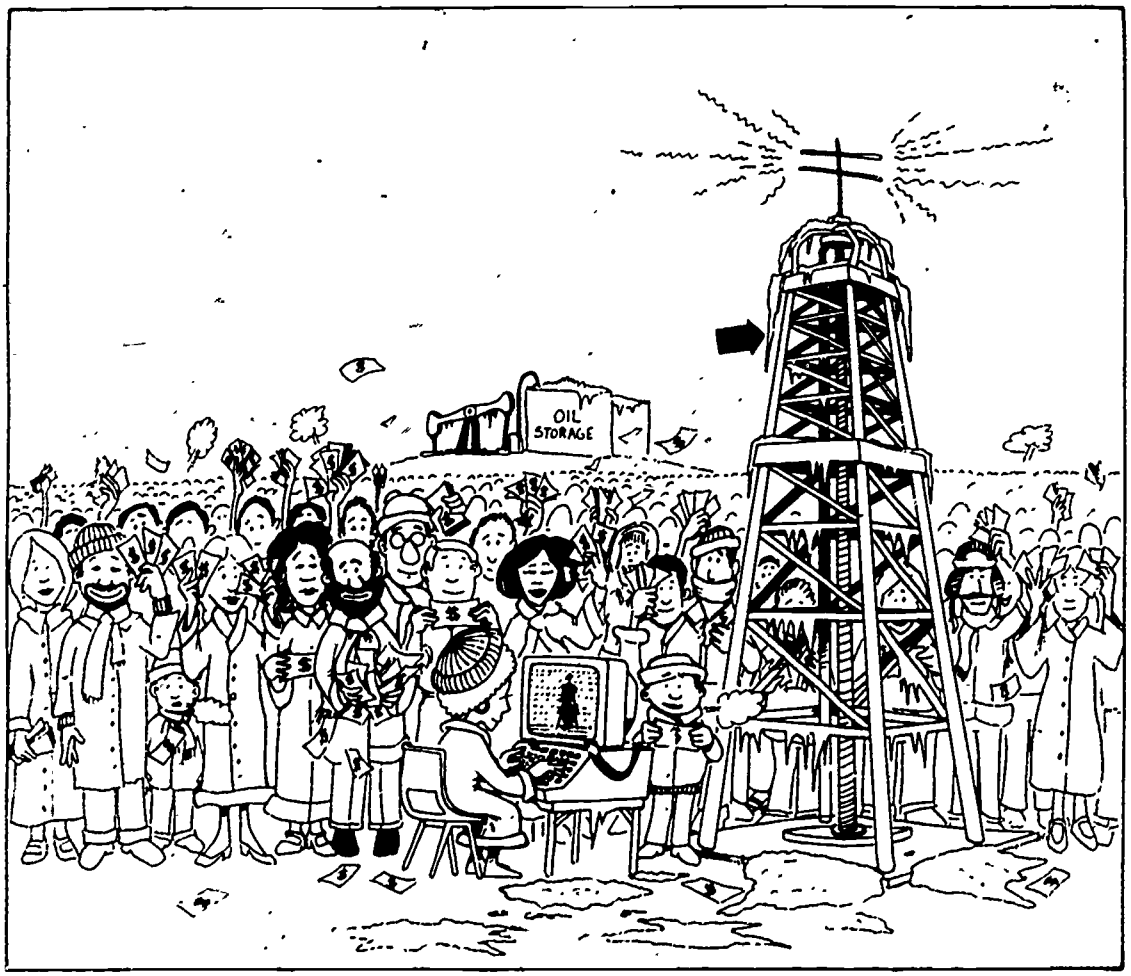

Figure 4. Sample illustration for the Organized Keyword Picture condition (From Shriberg et al., Note 3).

the previously listed attributes? That is, it is one thing to remember a frosty scene with a mass of people clutching dollar bills and watching a computer terminal operator beside an oil well. It is quite another, however, to decode these pictorial symbols into their appropriate attribute labels.

The results may be summarized as follows:

1. Organized keyword pictures did indeed facilitate students' associative memory for the community attributes, and by a substantial amount. In the two recognition experiments, keyword subjects outperformed controls by 70 to 90 percent; in the two recall experiments, the facilitation exceeded 100%. It should be noted, however, that the figures in the recall experiments are based on a liberal scoring system, which accepted appropriate paraphrases and concretizations. Nonetheless, even according to a strict verbatim criterion, the increase amounted to over 60% facilitation. The level of verbatim recall was low in all conditions. However, requiring verbatim responses neither eliminated the positive keyword effects nor placed keyword subjects at a disadvantage, as might have been anticipated on the basis of the previously mentioned difficulty-of-decoding conjecture.

Research now in progress is investigating the possibility of elevating students' level of verbatim recall through the use of additional keywords to represent the attributes themselves. Thus, for example, rather than provide pictorial symbols for the Fostoria attributes, one could provide pictorial keywords to represent the key words in the attributes, such as well for wealth, race horses for resources, tacks for technology, and pop for population. An integrated visual scenerio, based on this compound-keyword approach, appears as in Figure 5. Would students be able to keep each set of integrated

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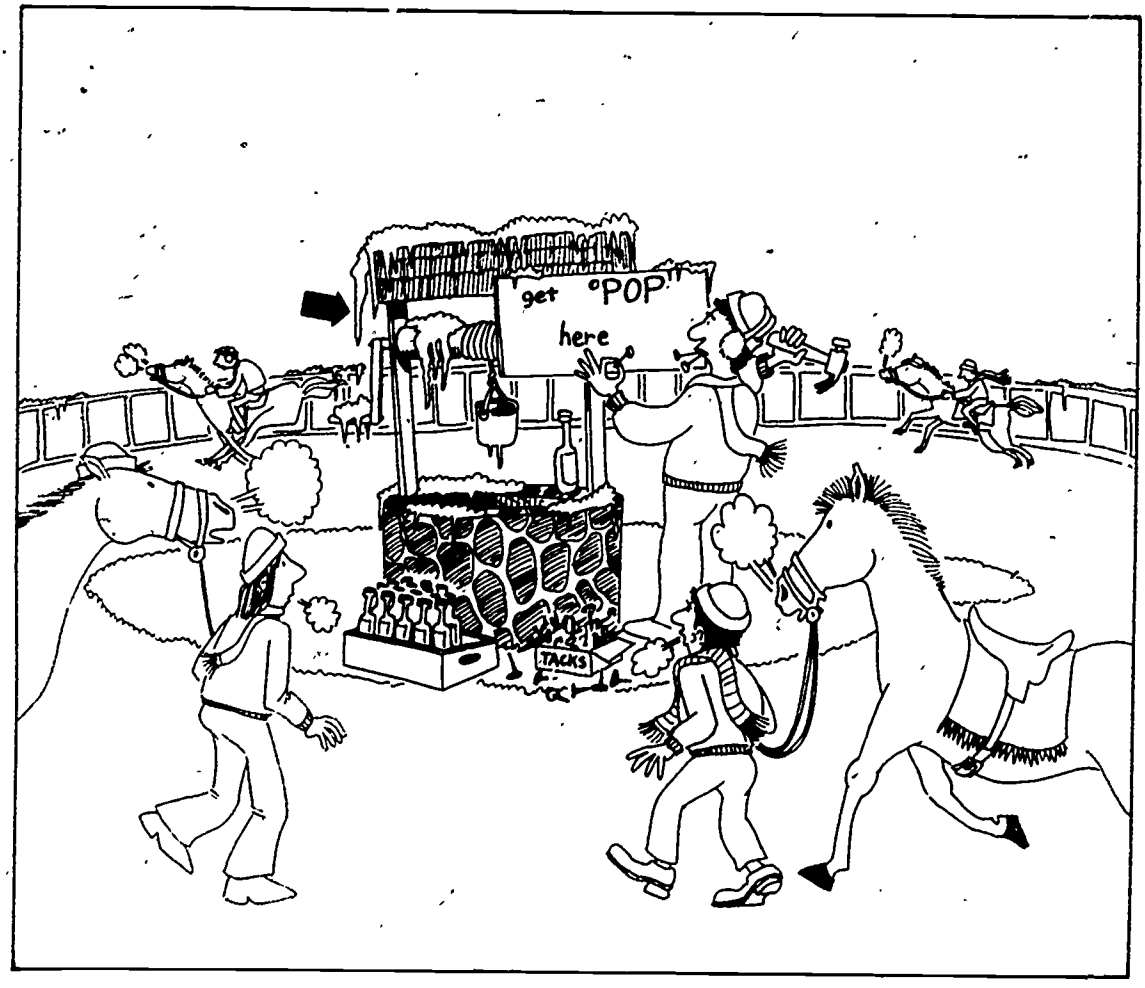

Figure 5. Sample illustration for the Organized Compound Keyword Picture condition.

attribute keywords distinct from, yet relatable to, the corresponding community keyword (here, frost)? If so, this type of compound mnemonic strategy may be just what is needed to facilitate retrieval of both the higher- and lower-level propositions of more complexly structured factual prose passages. This possibility will be returned to shortly. Another question associated with a compound keyword strategy is, Would the greater acoustic correspondence between the key attribute terms and their pictorial representations result in more efficient verbatim recall of the attributes, in comparison to verbatim recall in the combined keyword/symbol condition? Verbatim responses may be desired in certain situations and, thus, the answer to this question is important.

2. As predicted, organized pictures without keywords produced the same level of attribute organization as did organized keyword-pictures, but the level of correct attribute/community pairings was considerably lower. In fact, with the ten-community paragraphs, the number of attributes and communities correctly associated by organized picture subjects approximated that of control subjects.

3. Simple symbolic representations of the attributes (i.e., non-integrated pictures without keywords) were totally ineffective with respect to students either acquiring attribute/community associations or grouping together appropriate attributes. Thus, for this particular task, separate pictorial interpretations were insufficient to boost performance.

Are there differences associated with different prose-learning variations of the keyword method? In the Organized Keyword Picture condition of the

study just discussed, each name concept was integrated (via its keyword) with all of its associated attributes, in a single picture. Clearly, this is not the only kind of keyword approach that could have been taken, as Christine McCormick recently demonstrated in her doctoral dissertation (McCormick, Note 4).

As in the Shriberg et al. (Note 3) study, McCormick's paragraphs contained multiple attributes per name. The passage content, however, consisted of brief biographies of four fictitious individuals. Five pieces of biographical information were associated with each person: the kind of environment in which the person was raised, what (s)he did as a child to earn spending money, and his or her present occupation, major hobby, and aspirations. In addition, rather than providing students with actual keyword illustrations, McCormick simply described the particular images to be generated by the students themselves. In each of these images, a keyword for the "famous" individual's name was to be related to a representation of the corresponding biographical data, in one of three ways:

1. Separate Keyword Pictures, where each piece of biographical information was separately related to the keyword. Thus, for each biography, five discrete scenes were to be imagined, each containing the same keyword paired with a different biographical attribute. The theoretical notion here is that the person's name will re-evoke each of the five keyword attribute scenes.

2. Linked Keyword Pictures, where the keyword is related to the first piece of biographical information, and then the first piece of information (sans keyword) is related to the second, the second (sans first) is related to the third, etc. As in the Separate Keyword Pictures condition, five discrete scenes are to be produced. However, each biographical attribute

(except the last one mentioned) is involved in two of the scenes. The theoretical notion here is that of a scene-linked chain: The person's name will re-evoke the scene involving the keyword and the first attribute, recall of the first attribute will then re-evoke the scene involving the second attribute, etc.

3. Cumulative Keyword Picture, where the student starts with the keyword and first biographical attribute, and cumulatively incorporates each new attribute into a single integrated image. This condition resembles the Organized Keyword Picture condition of the previous study except that the components of the resulting picture are built up successively rather than presented simultaneously. The theoretical notion is that the ultimate scene will afford a thematic integration of the keyword and set of corresponding biographical attributes.

An example of each of these keyword approaches is provided in Table 4 for the ubiquitous Charlene McKune. Two control conditions were also employed, one with once-repeated biographical attributes (as in the Separate Keyword Pictures and Linked Keyword Pictures conditions); and one with multiply-repeated biographical attributes (as in the Cumulative Keyword Picture condition). Performance was based on 20 cued-recall questions, with each question relating to a specific piece of information about a specific individual. Two different question orders (sequential and scrambled) were also incorporated.

Let me now attempt to summarize the major findings:

1. All three keyword approaches resulted in increased levels of biographical-information recall (anywhere from 25-40 percent increases).

Table 4

Example of Three Different Keyword Variations for Factual Prose

(From McCormick, Note 4)

Sentence	Condition: Separate Keyword Pictures	Linked Keyword Pictures	Cumulative Keyword Picture
	"Make up a picture in your head of..."		
1. While Charlene McKune was growing up, she and her family led an interesting life traveling on their houseboat.	a RACCOON standing on the deck of a houseboat	a RACCOON standing on the deck of a houseboat	a RACCOON standing on the deck of a houseboat
2. During her school years, McKune earned extra money delivering newspapers.	a RACCOON throwing newspapers onto a doorstep	newspapers being thrown to the shore from the deck of a houseboat	a RACCOON standing on the deck of a houseboat throwing newspapers
3. McKune was always interested in whatever was happening around her, and so she eventually became a TV news reporter.	a RACCOON being interviewed by a TV reporter	a TV reporter throwing newspapers onto a doorstep	a RACCOON standing on the deck of a houseboat throwing newspapers to a TV reporter on shore
4. In her spare time, McKune loves to paint.	a RACCOON painting a picture	a TV reporter painting a picture	a RACCOON standing on the deck of a houseboat throwing newspapers to a TV reporter on shore who is painting a picture
5. Although McKune is not particularly athletic, she still dreams of some day winning an Olympic gold medal.	a RACCOON with an Olympic gold medal around its neck	an Olympic gold medal hung on a painting	a RACCOON standing on the deck of a houseboat throwing newspapers to a TV reporter on shore who is painting a picture of an Olympic gold medal

The smaller effects in this study, in comparison to the others, may have been due in part to the finding that in each of the keyword conditions, story information was often confused with other information about the same individual. For example, Charlene McKune may have been remembered as being a painter rather than as painting for a hobby. Such a finding is of considerable interest in that: (a) four of the five attribute categories had conceptual overlap to some extent (i.e., type of work while younger, present occupation, present hobby, and aspirations all relate to types of activities); and (b) the experimenter did not provide students with a specific strategy (mnemonic or otherwise) for relating passage information to its appropriate question category. Subsequent mnemonic prose investigations--including extensions to more complex prose types--will take these issues into consideration.

2. The preponderance of control subjects' overt errors consisted of confusing different pieces of different individual's biographies. Moreover, control subjects' recall of one piece of biographical information was virtually unrelated to the probability of their recalling the next piece of information about the same person. The same tended to be true for separate keyword subjects. In contrast, the recall of linked and cumulative keyword subjects was highly dependent on the correctness of their immediately preceding response. That is, they were much more likely to remember a biographical fact if they had remembered the preceding fact about the same person than if they had forgotten it. Interestingly--and consistent with the theoretically different processes associated with the various keyword approaches--when the questions

were asked in a scrambled order (i.e., different from the original order within a paragraph), the response-dependency pattern was reduced considerably in the linked, though not in the cumulative, keyword condition.

Thus, as with the two other recent investigations, the results of the McCormick (Note 4) study are very encouraging with respect to the potential for applying pictorial mnemonic strategies to factual prose passages. As will now be argued, however, the ultimate versatility of a mnemonic approach depends on how successfully it can be adapted to passages containing a variety of connected propositions at different levels of structural importance.

Pictorial Mnemonic Strategies for Complex Prose

Unlike what was written in the immediately preceding section, which was based on empirical fact, what is written here is based largely on speculation and should be recognized as such. Hopefully, at least fragments of this speculation will have been put to empirical test within the next few years. We consider here strategies and strategy combinations that are likely to enhance students' comprehension and retention of both a text's main ideas and its details. This statement implies that we will need to concentrate simultaneously on a text's macropropositions, its micropropositions, and its inter-propositional relationships. Let us new examine three possible approaches for doing this.

Nonmnemonic Strategies

I will have little to say about this approach. Many examples of popular nonmnemonic prose-learning strategies have been provided throughout the

paper and elsewhere. These include strategies designed to increase understanding of a text's structure, as well as important concepts described in the text. Such strategies typically involve a distillation of the details in favor of themes and major ideas communicated by the text. Other strategies operate within the text structure to provide hierarchically-ordered retrieval cues. To date, however, there is little evidence that these retrieval cues really do help one to retrieve the specific details that are waiting at the end of the path. That is, getting to a newly learned piece of information does not guarantee getting it. And to the extent that the gotten-to information is nonobvious--in the sense of it not being easily relatable to an individual's prior knowledge--there is no reason to expect that nonmnemonic prose-learning strategies will be effective.

A simple example will be offered from the area of vocabulary learning. In three recently completed studies (Levin, McCormick, Berry, Miller, & Pressley, in press; Pressley, Levin, & Miller, in press; and Pressley, Levin, Kuiper, Bryant, & Michener, Note 5), we have examined a host of strategies deemed by reading theorists and practitioners as "effective" for vocabulary instruction. The strategies consist of a variety of semantic-, contextual-, and schema-based approaches. In none of the approximately ten experiments that we have conducted have such nonmnemonic strategies improved subjects' (both adults' and children's) acquisition of new vocabulary items. In contrast, adaptations of the mnemonic keyword method have substantially facilitated performance.

It is not that nonmnemonic semantic alternatives are inherently poor strategies; rather, they are poor strategies when it comes to coding unfamiliar

terms for later retrieval. That is, interacting with a new word and its definition on a semantic level may well enhance certain types of performance--as Pressley et al. (Note 5) found out--but not performance in which vocabulary item/definition associations are critical, such as when having to recall or recognize a definition in response to a vocabulary item. The keyword method does provide the needed direct link between a vocabulary item and its definition and, consequently, associative performance is facilitated.

I think that one can extend the same argument to the acquisition of new information within a prose passage. The keyword method experiments reported in the preceding section suggest that one should at least listen to--if not embrace--the argument. The bottom line is that I do not believe that exclusively nonmnemonic prose-learning strategies will as effectively deal with our dual "macro"/"micro" concerns as will strategies that do contain a mnemonic component.

Compound Mnemonic Strategies

Note, however, by the way I worded the last sentence, that I am not saying that all texts should be exclusively processed mnemonically at all times. What I am saying is that at least some parts of some texts should at some times. It is too soon yet to say whether or not all parts of certain prose passages should be mnemonically processed. The relevant data have not yet been collected, but that is the topic of speculation for this subsection.

We know by now that factual information in a prose passage can be mnemonically coded in an efficient manner. But what about a passage's higher-order content (information) and structure (connections)? Actually, we can say something about mnemonic strategies and higher-order passage content. The Shriberg et al. (in press) "famous" people passages contained

both higher-order information (main accomplishments) and lower-order information (additional details about the accomplishments). The mnemonic keyword method facilitated students' recall of the higher-order information. This example is offered simply to point out that "higher-order" and "lower-order" propositional information must always be defined relative to the passage at hand. Thus, although a specific accomplishment for a specific person may well represent a trivial detail in one passage, it may represent another passage's raison d'être (as, for example, in a biography).

More complex factual prose passages differ from the above "famous" people example in at least three ways. First, greater dependence on text/schema interactions is required in order for new information to be related to existing knowledge. Moreover, in comparison to lower-level text information, higher-order information is generally stated at a higher level of abstraction and is associated with a greater number of inter-propositional connections. The text/schema interaction issue must be considered with respect to any prose-learning strategy employed, be it mnemonic or nonmnemonic. If one cannot bring one's prior knowledge to bear on at least some aspect of the text content (either as presented or as recoded), then the strategy will be ineffectual.

What is of concern here, then, is whether or not exclusively mnemonic strategies can be devised to permit an efficient coding of a passage's micropropositions, while at the same time permitting an efficient coding of the more abstract, multiply-connected macropropositions. Enough research has been done to expect success at the "micro" level. Moreover, the limited research on mnemonically-coded abstract prose concepts (reported earlier) also bodes well for combining pictorial representations and pictorial

transformations. What has yet to be touched upon is the propositional-connection issue. Can this be effectively dealt with strictly from a mnemonic perspective? And if so, can one use the same mnemonic system to represent passage content and passage structure, or can different mnemonic systems be combined to serve unique functions? In addition, are there limits to the amount of mnemonic content and structure that can be coded for a given passage? Finally, even if such exclusive mnemonic processing of text were to prove to be effective relative to a no-strategy control condition, how would it fare relative to either alternative nonmnemonic strategies or mnemonic/nonmnemonic strategy combinations? My own hunch is that neither exclusively nonmnemonic strategies nor exclusively mnemonic strategies will prove to be as effective as mnemonic/nonmnemonic combinations, the topic with which this paper comes to a close.

Combined Mnemonic/Nonmnemonic Strategies

An interesting series of demonstrations by Snowman, Krebs, and their associates (Krebs, Snowman, & Smith, 1978; Snowman, Krebs, & Lockhart, 1980; Snowman, Krebs, & Kelly, Note 6) will be used to indicate some promising research avenues. These investigators have shown--in the context of actual college-level courses on "study skills"--that inefficient prose processors can be taught combined mnemonic/nonmnemonic strategies to improve their prose-learning performance substantially. The basic instructional procedures, which are developed over several weeks, combine a text-analysis macrostructure strategy with a mnemonic microstructure strategy. The text-analysis strategy is essentially a four-tiered simplification of Meyer's (1975) system. Its primary purpose is to get students to focus on the text structure, abstracting

themes and coding propositions with respect to their importance and relationship to other propositions. The mnemonic strategy is the method of loci applied to the details at the lowest level of the prose hierarchy, which enables students to remember the facts and examples associated with the higher-level propositions.

The Snowman and Krebs approach merits scrutiny, and it clearly invites additional research. Based on the work out of our laboratory, reported here and elsewhere (e.g., Levin, 1981a), it would certainly appear that mnemonic strategies other than the method of loci: (a) would prove useful for certain types of to-be-coded passage information; (b) would be better suited to cued-recall performance measures (rather than the free-recall measures employed by Snowman and Krebs); and (c) could be used in conjunction with the loci method as a compound mnemonic strategy (see, in particular, Levin, McCormick, & Dretzke, in press). Regarding the last point, strategy combinations involving the loci method and other mnemonic systems could be applied to higher-order passage content and structural connections, as was suggested in the immediately preceding subsection.

A concluding excursion. Although I do not have a firm fix on how these notions could be "systematized", either within or across passages, let me conclude by taking an N=1 voyage into the target paragraph of Meyer's (1975) Parakeet passage, which is reproduced here:

> The wide variety of color of parakeets that are available on the market today resulted from careful breeding of the color mutant offspring of light green-bodied and yellow-faced parakeets. The light green body and yellow face color combination is the color of parakeets in their natural habitat, Australia. The first living parakeets were brought to Europe from Australia by John Gould, a naturalist, in 1840. The first color mutation appeared in 1872

> in Belgium; these birds were completely yellow. The most popular color of parakeets in the United States is sky-blue. These birds have sky-blue bodies and white faces; this color mutation occurred in 1878 in Europe. There are over 66 different colors of parakeets listed by the Color and Technical Committee of the Budgerigar Society. In addition to the original light green-bodied and yellow-faced birds, colors of parakeets include varying shades of violets, blues, grays, greens, yellows, whites and multi-colored variations (Meyer, 1975, p. 201).

What follows now is a personalized account of an effort after understanding and remembering the content of this paragraph. In the account, I will indicate the specific strategies employed, as well as the relevant self-monitoring activity that accompanied these strategies (see Figure 1).

The superordinate concept in this paragraph--and in the passage from which the paragraph was taken--is parakeet. Yes, I know that a parakeet is a small bird, but that's about all. A check in the dictionary shows that a parakeet is actually a member of the parrot family, and I think I have a better-developed schema of parrot. What is more, keet could be thought of as a diminutive, and so the "small parrot" analogy may indeed serve me well. The specific topic of the paragraph is the color of parakeets and, in particular: (i) the many varieties of color that there are today; and (ii) the history of their evolution.

● Comment: The above illustrates use of a variety of nonmnemonic strategies (including text analysis, rereading, summarizing, self-questioning, and schemata activation) and the potential use of the mnemonic keyword method (i.e., parakeet = parrot + keet; keet resembles kid, or someone small).

Concerning history, the most important place is Australia, the most important date is 1840, and the most important name is John Gould.

I can well imagine parrots in Australia, and of course they have green bodies and yellow faces. I can also see them flying wild in the midst of kangaroos and koala bears. I can also focus on or draw a map of Australia to help cement the Australia-parakeet connection. In addition, I can see a ship sailing from Australia to Europe. The ship has a bunch of deep sea divers on it. They're trying to dive, but can't; their feet are glued to the ship boards. The divers are important because via the mnemonic digit/symbol method, that gives me d-v-r-s = 1840, the critical year of John Gould, the naturalist. Why John Gould? Two reasons: 1. The divers' feet were glued to the deck. Remember? 2. The connection in my mind is also mediated by an Australian-swimmer connection, which elicits the name Shane Gould, the Aussie Olympic swimmer of years gone by. Why John? Why not?

- Comment: The above illustrates use of the nonmnemonic strategies of concretizations (here, maps) and schemata activation (including idiosyncratic associations, such as Shane Gould), as well as the mnemonic digit/symbol (1840) and keyword (glued-Gould) strategies.

Having gotten to Europe, we learn that two dates and two places are significant. One date is 1872, when an all-yellow color variation appeared in Belgium. Because I already know that we're in the 1800s (from the divers), life is made simpler by focussing on just the 72, which is coded as coin according to the Lorayne and Lucas (1974) digit/symbol method. As our ship comes into port, I can see an old man with a beard coming on board ship. He is carrying a bright yellow coin, which he offers the captain in exchange for the ship's yellow bell (= Belgium).

I also remember my map, which shows a route from Australia to southeastern Europe, through Gibraltar, and up to Belgium--realizing full well that I have fabricated this particular route just to get from "somewhere" in Europe to Belgium. The old man (a hermit?) then takes the ship's bell to his cave (= 78), "who knows where" in Europe. The bell hangs from the cave entrance while the hermit sits there just gazing at the bright blue sky and white puffy clouds. This of course, tells me that in 1878, a blue-and-white color variation of parakeet appeared "somewhere" in Europe.

Comment: The above illustrates use of nonmnemonic maps and schemata once again (including a plausible scenario of a route traveled by), as well as the mnemonic digit/symbol method, keyword method (Belgium = bell), and link method (in the form of an integrated story, to get from one critical date to the next).

Finally, concerning colors of parakeets today: Of course there are green and yellow varieties, from their parrot ancestors. Also, in encountering the unfamiliar term buderigar, I hear a familiar budgie bell ring inside. Budgie must either be a derivative, or the informal term [a dictionary check confirms the latter]. At least some budgies I know are blue and white, and so I make either the inferential or synonymic leap to parakeets [a dictionary check again confirms the latter]. Thus, we have green, yellow, blue (and its relative, purple or violet), white (and its neighbor, gray), and--as the passage said--numerous other variations (including multi-colored ones). But how many exactly? I can't tell exactly, but I do see a "Miss Parakeet" content, with a very important-looking judge perusing a long list of entries. The

judge is, of course, more than just important looking; he tells me via his j-g that there are 66 (= j-g) names on a "Society" list. But, then, there must be more than 66, because some has just handed him a list of late entrants.

- Comment: The above illustrates the application of nonmnemonic schemata yet again, including inference generation through self-questioning. The mnemonic digit/symbol numbering system is applied again as well.

As should have been apparent, in performing this exercise I had to make repeated use of both existing nonmnemonic schemata and appropriate mnemonic systems. I was even able to combine the two in places (e.g., Shane Gould, as a link between Australia and John Gould). Note also, that in order to organize my mnemonic strategies in an effective manner, I was forced into performing a nonmnemonic text analysis of sorts. The product of this analysis could have taken shape in any number of forms, structured either propositionally, cartographically, or historically, with the last either in proper or reversed sequence.

Having spent considerable time with the paragraph applying the various analyses and devices, I am now willing to risk the following conclusions:

1. It is indeed possible to devise combined mnemonic/nonmnemonic prose-learning strategies that "work".

2. Getting strategies that "work" requires work, and work in this case involves both effort and time. One might be further disheartened to learn that the paragraph dissected here was only one of four that comprised the Meyer (1975) Parakeet passage. Thus, more work lies ahead for the serious student.

3. Such strategies, when presented to students in an optimally structured form, should be effective. Consistent with the theme of this paper, pictures represent a class of prose adjuncts that should be exploited when one's goal is to enhance students' comprehension or memory.

4. The strategies offered and taught to students should be geared appropriately to their prior knowledge and skill levels. The complexity of strategies such as the ones illustrated here can quickly get out of hand, with the result of frustrating or "turning off" the student.

5. It is unlikely that the facts surrounding the color evolution of the parakeet, as we know it today, will soon be forgotten by the present author. The question of how to differentiate between the "real" and "imagined" information that I now have dancing around in my head is an interesting one, as is the question of what will become of that information as time goes by.

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